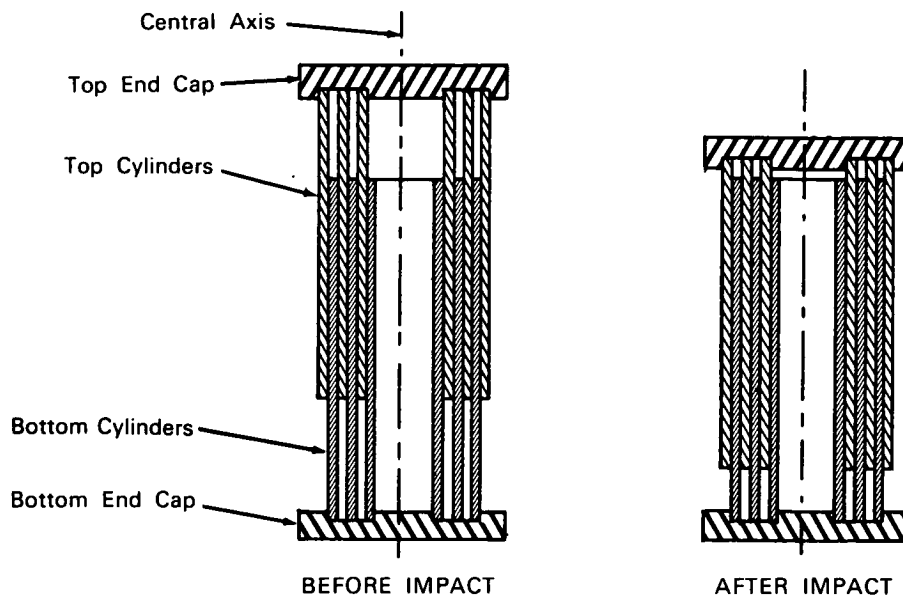


NASA TECH BRIEF



This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

Kinetic-Energy Absorber Employs Frictional Force Between Mating Cylinders



The problem: To design a kinetic-energy absorbing device that will safely decelerate a spacecraft as it impacts on a landing surface. A number of designs have been made and investigated by NASA in an effort to provide a compact, lightweight device that will have the required high energy-absorbing capacity and be operational in severe environments.

The solution: A device employing a series of coaxial, mating cylindrical surfaces with high frictional resistance to relative motion between the surfaces when axial impact forces are applied to the device.

How it's done: Cross sections of the basic design are shown in the illustration. The top end cap is

solidly attached to the vehicle. The bottom end cap is solidly attached to a pad that impacts on a landing surface. Thin sheets of metal in the form of cylinders are concentrically spaced and fixed to the top end cap; a similar set of cylindrical sheets, interleaved with the top set, are fixed to the bottom end cap. These interleaving sheets are wound tightly upon each other to provide a high frictional resistance in the direction of the central axis of the device. Motion of the top end cap, initiated on the application of impact forces to the bottom end cap, will drive the top set of cylindrical sheets toward the bottom end cap in opposition to the frictional forces between the mating surfaces. In reacting to these forces, the spacecraft decelerates, and its kinetic energy is converted into heat in the absorber.

(continued overleaf)

Advantages of this frictional columnar design include: (1) very large area of frictional contact between the sheets, which provides for high energy absorption per unit weight of the device; (2) lateral pressure between the multiple mating surfaces, which strengthens the column against buckling forces; and (3) absence of any fragmenting components which could prove hazardous to adjacent structures or persons. Several modifications may be made to the basic design; e.g.: (1) The free spaces between the sheets that exist near the top and bottom of the device before impact may be filled with a light but rigid material to improve the resistance to column buckling. (2) The contact surfaces may be ridged or milled to increase the coefficient of friction, or polished and lubricated to decrease the coefficient of friction. (3) Devices operating on this principle can be built to provide desired force-vs-time relations in a number of ways. In one way, the surfaces could be treated to have different coefficients of friction at different parts of the stroke. Other ways of controlling the force-vs-time relation include varying the wall thickness along the length of the mating sheets; and using sheets of differing lengths so that at the start of the stroke, fewer mating surfaces are in contact.

The basic design, as well as the modifications suggested above, results in a nonreusable device. It may be feasible to develop a reusable device by incorporating a system of springs and linkages in the basic design.

Note:

Suggested non-space uses for the kinetic energy absorber system include:

1. Passenger-elevator emergency safety decelerators;
2. Energy-absorption and structural members in automotive, aircraft, and railroad seats;
3. Backup energy-absorption devices for equipment involving human test subjects (drop towers, vibration machines);
4. Safety overload devices for production machinery;
5. Aircraft landing gear.

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